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Impressioning Manual for Amateur Locksmiths

1.0. INTRODUCTION

1.1. Impressioning is a method of fitting a key to a lock without taking the lock apart. Basically, here is how it works: A key blank is inserted into the lock, then turned to bind the pins. When the pins are binding, the key is wiggled or moved to produce marks on the blank. If a pin is at the shear line it will not bind, and no marking will occur. When marks are found, the places on the blank which have marks are then filed. The marking and filing process is repeated as necessary to produce a working key which raises all the pins to the shear line, thus opening the lock. Although impressioning is not hard to learn, it does take some practice to develop the skill. Of course, the more you practice, the easier it gets!

1.2. How long does it take to impression a key? With practice and by making use of shortcuts, it is not unusual to be able to make a key in about 10 minutes. Some locks will take longer. Sometimes as little as 5 minutes is possible if you are both lucky and skilled. If you try to pick a lock, you don't know in advance if it will take one minute or thirty. With impressioning, opening a lock is a more reliable and predictable process.

2.0. PRACTICE LOCKS

2.1. You can start out with any lock, but I will suggest starting with an average sized four-pin Master padlock. They are easy to impression, and blanks can be easily obtained at a hardware store. You should get more than one blank for practicing. Five is probably a reasonable number.

2.2. Below are some depth and spacing data for the Master padlock, which as you will see later, can be useful (although not necessary). The depths are measured from the bottom of the blade of the key, up to the bottom of the cut where a pin will rest.

Cut #	Depth	Cut #	Depth
0	.280"	4	.220"
1	.265"	5	.205"
2	.250"	6	.190"
3	.235"	7	.175"

The distance from the shoulder of the key to the first pin is .185", and the spacing between pins is .125" (you really don't need these last two numbers, but they may be helpful references as you are first learning to recognize what the marks look like).

2.3. Another good approach to using a practice lock is similar to that sometimes recommended for learning picking: Get a lock cylinder and remove all the pin stacks but one. After you have impressioned the one pin lock, add another pin stack and try again. Continue adding pin stacks until you can impression the whole lock.

3.0. FILES

3.1. Six inch, #4 Swiss-cut round or pippin files are normally used for impressioning (the files are called 6", but are actually about 8" long including the tang). Both types of files taper down to a smaller cross- sectional size towards the tip. The round file is usually used in conjunction with a small flat or triangular file which is used to shape the flat sides of the cuts on a key. The pippin file has sort of a teardrop cross section, rounded on one side, and with two flat surfaces meeting

at a knife edge on the other side. The flat surfaces are used like the flat file above to shape the sides of cuts.

Chances are that you won't find these kind of files in your local hardware store, just because they have finer teeth that are required for most purposes. Locksmith suppliers carry them, of course. You can also get them through a machinist's or jeweler's supply house.

3.2. The particular #4 Swiss-cut pattern is used for impressioning work because it leaves a very fine, slightly dull, and slightly corrugated surface on the blank, which permits visible marks to be made by the pins rubbing on the blank with very little pressure. A few locksmiths use a #2 Swiss cut pattern because it cuts faster, but most authors specify the #4. Having tried both types, I strongly recommend the #4 also.

3.3. It is also a good idea to get a handle for the file, as it permits better and more comfortable control of the file. A file card is a special brush made to clean the teeth of a file. The soft brass of the key blanks tends to clog up the teeth on an impressioning file a little bit, which affects the quality of the fine surface you are trying to produce on the blank. Don't be cheap - get a file card too.

3.4. A few tips on using files: Files cut only on the forward stroke. So, push the file slowly and evenly forward with gentle cutting pressure, and draw back the file without any cutting pressure. Particularly when impressioning, do not apply pressure when drawing back the file, as it tends to polish the surface of the blank (a dull surface is needed when impressioning). Hold the file with an extended index finger pushing down on the top edge of the file to control cutting pressure. Light cutting pressure will produce the finest finish for producing visible marks. Use heavier pressure to remove material rapidly, followed by lighter strokes to finish the surface for marking.

4.0. BLANKS

4.1. Soft brass blanks are the best for impressioning. Steel blanks are much harder than is desirable, and aluminum blanks develop fatigue cracks easily when using hard turning tension. If you can only find bright plated brass blanks, you will have to file the plating off the top of the blade with your impressioning file. Only file deep enough to remove the plating, because with some locks a #0 cut requires the full un-cut height of the blade. With the plain brass blanks, you also need to smooth the top of the blade with your impressioning file in order to leave a surface that will show marks - just be careful not to take off too much.

note: Some lock manufacturers use #0 and others use #1 to indicate the highest depth cut. For consistency, #0 will be used in this manual when referring to the highest depth cut (unless otherwise noted), which is equal to or very close to the full un-cut height of the blade of the key blank. A #1 cut refers to a cut which is one step lower than the un-cut height of the blank.

4.2. Some people like to prepare the blanks by either thinning them down in width with a flat file, or knife edging the top of the blade. In both cases the idea is that a very thin piece of metal can more easily be deformed than a thick one. In the case of thinning down the blade, it can also be wiggled around more in the keyway. When thinning a blade, do not thin the area immediately adjacent to the shoulder of the blank where the blade enters the keyway. You will be applying hard turning tension on the blank later and it is important not to weaken it at the point where most of the turning stress is applied.

Knife edging is used more often when the pull-out method (more about this method below in section 5.5.) of obtaining marks is to be used. Knife edging is used to thin only the top of the blade to make the initial marks more visible. To knife edge the blade, file both sides of the top

the blade at about a 45 degree angle. The idea is not to make it really sharp like a knife, just to make the edge weak enough to mark more easily on the top surface.

4.3. As an example of the utility of knife edging or thinning, I took a new blank for a Master padlock and prepared the flat top surface of the blade with my impressioning file. After some wiggling, I could see one mark at the tip of the blade, which is enough to start with. But, I then knife edged the blade and wiggled some more. This time I could easily see marks from all four pins. With the knife edging, less wiggling was required and the marks were much more visible.

5.0. MAKING THE MARKS

5.1. There are three commonly used methods for making the marks. They are called wiggling, tapping, and pulling. In each of the methods, the blank is inserted in the keyway, then turned hard to bind the pins. Usually turning pressure is applied in the direction you want the lock to open, but you can try both directions to see which leaves better marks. It is important to make sure that the blank is evenly seated on the bottom of the keyway before applying turning pressure. If you are holding it tilted, some of the pins will already be pushed up and won't leave any marks.

5.2. When impressioning, you will need something to hold the blank because of the repeated hard turning tension used (the tension is harder than is used for picking, but not hard enough to break the blank). A small pair of vice-grips (no larger than the 5" size) works well. Attach the vice-grips like a handle, aligned with the long the axis of the key blade (not at a right angle like a turning wrench). There are also some commercially made handles for impressioning. There is at least one with a trigger handle to help pull out the blank uniformly each time, when using the pull-out method.

5.3. Wiggling is accomplished by applying turning tension, then wiggling the blank up and down causing the top of the blank to rub against the tips of the bound lower pins.

5.4. Tapping is a variation of wiggling. The blank is inserted into the keyway, then a steel rod is placed in the hole in the bow (handle) of the key to provide turning tension. A small mallet is used to tap on the bow to make the impressions. Tapping on the top of the bow pushes up the tip of the key by lever action, and tapping on the bottom of the bow pushes up the back of the key by direct action.

5.5. The pull-out method only works after you have cut down to at least a #1 depth, hence the popularity of knife edging the blank, then using the wiggle method to see if there are any #0 cuts to start with. To use the pull-out method, apply turning tension, then pull out on the blank (don't try this method on disk or wafer locks, because the disks may bend or break). Unlike the wiggle and tapping methods, the marks produced by pulling will not be exactly where the pins are, the distance away being related to how far you pull the blank out (maybe 1/16"). For this reason it is helpful to scribe lines down the side of the blank after the pin locations are found by the wiggle method, to use as a reference when filing. The advantage of the pull-out method is that it can leave more easily visible marks than the previously mentioned methods.

5.6. There is more than one way to implement the pull-out method. One technique involves attaching a C-clamp to the bow, then using the C- clamp to provide turning tension on the blank. A screwdriver is placed between the side of the bottom end of the C-clamp and the face of the lock, then the screwdriver is twisted to pry the C-clamp (and therefore the blank) in a direction out from the face of the lock (no more than about 1/16").

5.7. An effective hybrid approach is to first put turning pressure on the blank, then add pulling pressure (without actually pulling the blank out enough to start making marks - the pressure is just take up any slack between the blank and the pins and to put more tension on the pins) using your vice-grips or a commercial impressioning handle, then bump or tap the blank up and down to make the marks stand out more than more than they would otherwise. Remember to file where the pins are, as with other pull-out techniques (see section 5.5. above).

5.8. There is an optimum amount of turning tension to apply to the blank for any particular lock. It is the rubbing action of the pins against the blank that polishes the surface of the blank to produce the little marks used for impressioning. If too little tension is used, the pins will move too easily and not mark. If too much turning tension is used, the pins will jam and not mark - the pins have to be able to move a little to polish the blank's surface.

5.9 You will have better control of the impressioning action if you hold the blank and handle with your hand up near the head of the blank and the face of the lock, rather than having your hand farther away.

5.10. Wrist action, rather than action from the elbow is more effective in moving the blank within the keyway to produce marks - the recommended action is more to tilt the key up and down from the wrist with a bit of a snap, verses just lifting and lowering the blank.

6.0. SEEING THE MARKS

6.1. The mere act of preparing the flat top of a soft brass blank with an impressioning file, inserting the blank in a lock and removing it, without any wiggling or turning, will leave marks on the blank. There will be some streak marks where the pins have dragged across the specially prepared surface. Try it and you will know these marks look like so you will not confuse them later with the useful marks.

6.2. The useful marks you get are not really depressions in the surface of the blank (except maybe when a pin is almost at the shear line - if you start seeing deep gouges, the lock is probably about to open). A mark is normally just a subtle change in the reflectivity of the surface of the blank. The impressioning file leaves a slightly dull finish, and marking will slightly polish it. To see the marks turn the blank in the light. When you hold it at the right angle, the marks appear as little tiny shiny dots. They can be hard to see in bright light, so if working outdoors, sun glasses may be helpful. Some people like to use a magnifier to see the tiny dots - even with a magnifier, you still have to turn the blank in the light just right to see the marks. With a little practice, you will locate the marks very quickly.

6.3. If impressioning a dirty or weathered lock, you may find little specks of debris on the surface of the blank after marking. If there any doubt as to what you are looking at, wipe off the top of the blank to see if you actually have a mark rather than a tiny speck of dirt.

7.0. FILING THE MARKS

7.1. The rule for filing marks is simple. If you see a mark, you file there - if not, you don't (except when using the pull-out method - in which case if you see a mark, you file where the pins are; see section 5.5., above). Whatever you do, don't be tempted to guess - if you're not sure if you have a mark or not, don't file there. Work on making and seeing the marks first.

7.2. File only 2 or 3 strokes at a time before looking for more marks, because you only have to file a cut a few thousandths of an inch too deep, to pass by the shear line (a shortcut, allowing more filing at one time, follows in section 8.1.).

7.3. As the cuts are filed deeper the sides of the cuts will start to become parallel with each other, looking something like the letter U. If you leave them that way the key will get stuck in the lock. Use a flat file, or the flat side of your pippin file to angle the sides the cuts at about a 45 degree angle from vertical, making the sides of the cuts look more like the letter V. The bottoms of the cuts should remain rounded. It can be helpful to look at some other keys, then try to duplicate the shape of the cuts.

7.4. Some locks have fat pins and some lock have skinnier pins. There seems to be a natural tendency to use the middle part of the file, leaving fairly wide cuts. The cuts only need to have a radius a little bigger than the radius of the pin tips. For locks with skinny pins, try using the file more towards the tip, where it is narrower.

7.5. If you can see more than one mark at a time, it is ok to file them all at once or one at a time.

7.6. Sometimes a pin will stop marking before it reaches the shear line. So, don't be surprised when a pin that has stopped marking starts marking again after some of the other pins have been brought to down the shear line. Just keep filing until the pin stops marking again.

8.0. SOME USEFUL ACCESSORIES

8.1. For locks that are factory keyed, only certain standard pin depths are used. The standard pin depths are listed in "depth and spacing" manuals and code books available from locksmith suppliers. You can also figure out what the standard depths are (within certain tolerances) by measuring the cut depths on other keys for the same type of lock you are working on. If you think a lock is keyed to factory depths, there is no reason to look for new marks after only two or three file strokes. If you get a mark at some standard depth #n, then just file down the cut to the next standard depth, #n+1, and look for marks again.

It is helpful to have a key micrometer or dial caliper to measure the depths. A key machine can be used to speed up the impressioning process by quickly cutting down to the next standard depth. Punch type code machines, such as the Clipper are especially useful out in the field. If you use a machine to make the cuts, you will need to lightly touch up the surface of the cut with your impressioning file before looking for more marks.

9.0. SHORT PINS

9.1. Some locks use "short pins" for the #0 depth ~ #2 depth cuts. When short pins are present, you can look into the keyway and see the dividing line between the upper and lower pins. It is possible to "read" the short pins to determine the depth of cuts needed on the blank without any impressioning being required.

9.2. To identify the short pins visually, use a flashlight (or an otoscope, if you have one) and a straight pick, lift up all the pins as high as they will go, then look into the keyway. Withdraw the pick slowly to drop the pins one at a time. If you see the dividing line on a pin stack, depending on it's position in the keyway you can estimate the depth of cut for that pin from your experience with other locks of the same type, without doing any impressioning all. Again, if you are familiar with the particular type of lock, and you don't see any dividing lines at all, then you will know that you can start by filing down all the cuts to perhaps the #1 depth or maybe the #2 depth, etc., because you know that none of the cuts can be any shallower than that.

9.3. Another way to find the short pins is to use a probe. The probe is a straight pick, filed to a sharp point. Mine has a blade length of about 1-1/4" long. The height of the blade is about .055" at a distance of 1/2" from the tip. My probe has a series of dots down the side to measure how deep it is in the lock. To use the probe, lift up all the pins as high as they will go, then pull out the probe until the last pin drops. Slide the probe down the side of the pin and stop if you feel a dividing point between upper and lower pins. Note at which reference dot the probe is at, then push it all the way into the gap between the upper and lower pins. Note how much farther the probe has moved into the keyway. By measuring how far you can push the probe into the gap, you can measure the size of the gap, and therefore determine the cut depth for that particular pin. Repeat the process for each pin. As an example, I have found that a #1 cut on a Schlage "C" keyway will barely probe - the dividing line can be felt, but the probe cannot be pushed between the upper and lower pins. In the same lock a #0 cut has a gap of about .020" - .025", which means that my probe can be pushed in a little less than 1/4". The Master padlock can also be probed: My particular probe will enter the gap of a #1 depth pin stack about 3/16", and will go in farther for a #0 depth pin stack.

9.4. Probing can also be used to assist picking. If you can tell which pins are short and which are longer before you start picking, you will have a better idea how you are going to need to manipulate the pins.

9.5. Probing will leave little scratches on the side of the pins, but it doesn't hurt the lock.

10.0. SPOOL PINS

10.1. Upper spool pins are no problem because the upper pins never go below the shear line when impressioning. A few locks have lower spool pins. Using the probe you can often feel the shoulder of the spool, which feels different than a short pin because of it's shape. If you find a lower spool pin, file down the cut for that pin until it stops marking. Impression all the other pins normally. When only the spool in is left to be impressioned the plug will turn a little and catch on the spool pin. At that point, file down the cut for the spool pin until it starts to mark again. Then continue filing it just a little bit more to bring the dividing line between the upper and lower pins down into alignment with the shear line.

11.0. PROBLEMS WITH BLANKS

11.1. Due to the stresses encountered during impressioning, sometimes a blank will start to crack, usually on the blade near the shoulder where it just enters the lock. If this happens, stop - you don't want a broken-off key in the lock to extract. You can duplicate the cracked blank on a machine or by hand, then continue impressioning with the new blank. If you don't have a key machine, or a key micrometer for duplicating the cracked key, there is an old method you can use: Smoke the blade of the cracked key blank over a candle, covering it with soot. Clamp it next to a new blank using a vice, C-clamp, vice-grips, etc., then file down the new blank until you just start to hit the soot on the old key blank. As soon as you start to scrape off the soot, stop filing. It is important not to go too deep.

11.2. If you are cracking blanks more than occasionally, you probably are using too much turning pressure. Strive for moderation - just enough pressure to make the marks.

11.3. Turning and wiggling a blank in one direction, then turning the other way and wiggling again tends to fatigue the blank faster than working in only one direction. So, especially watch for cracks if you are using both directions.

11.4. If you accidentally make a cut a little too deep, there a couple of ways to try to save the blank. It can be peened with a small hammer or pin punch on the side of the blade, just below the bottom of the cut to raise the bottom of the cut, or a little solder can be added to the bottom of the cut. Solder is very soft, however, and won't last long. So a duplicate will need to be made from your impressioned key pretty soon.

11.5. If you find that you have lowered a particular cut to the maximum depth (e.g. #9) without finding the shear line, you obviously have filed too far. To save the good part of your work, duplicate the blank except for the one overly-deep cut, then continue impressioning with the duplicate blank.

12.0. MASTER KEY SYSTEMS

12.1. After you have impressioned one lock in a master key system, the other locks will probably have only two or three pins with different depth cuts. If you impression a few different locks you will soon have a master key at some level.

13.0 DIRTY LOCKS

13.1. A lock that has been oiled can be extremely hard to impression. A long time ago, gasoline was used to flush out a dirty lock. Today, some no-residue electronics spray cleaner would probably work well. After flushing out the lock, you can speed up the drying by blowing some air into the keyway. There are canned compressed air "dusters" which are suitable for this purpose.

14.0. DISK TUMBLER LOCKS

14.1. Disk tumbler (wafer) locks can be easily impressioned using the same techniques described for pin tumbler locks. However, pull-out techniques should not be used because of possible damage to the disks.

14.2. Typically, a little less turning pressure is used when impressioning disk locks as compared to pin tumbler locks.

14.3. The impression marks made by disk locks may look different than the marks made by pin tumbler locks. Depending on exactly how the disk is contacting the blank, you can get anything from a small dot at the edge of the blank, to a straight line across the width of the blank.

14.4. Sometimes it is possible to determine the key cut depths for a disk lock without doing any impressioning at all. The technique is called "reading" the lock, and with practice it can be done in seconds. To read a disk lock, use a straight pick to lift up all the tumblers. Slowly pull out the pick watching each tumbler as it falls. You will see that some disks protrude further down into the keyway than others. Typical disk locks use 5 different depths, numbered #1 through #5, with a #1 cut being at or near to the full height of the key blade, and a #5 cut being the deepest. The #1 tumblers protrude the least amount into the keyway and the #5 cuts protrude the most. By comparing the amount each disk protrudes with respect to the other disks, and with respect to landmarks in the keyway (such as the side warding), it is possible to estimate the depth # of the cut. Usually, the difference between cut depths for disk locks ranges between .015" - .025", with .020" being very common. Here are some common depths:

cut #	depth	cut #	depth

1	.240"	4	.180"
2	.220"	5	.160"
3	.200"		

Specific depths for particular locks can be found in "depth and spacing" manuals, or by taking measurements on keys for other locks of the same type.

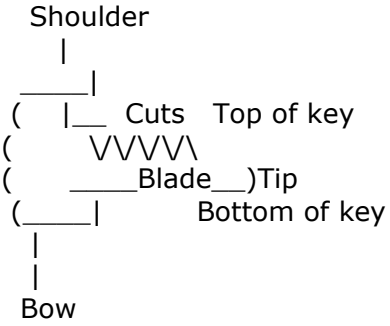
14.5. A disk tumbler lock must be in it's shell to be read properly, because the tumblers must be resting in the shell slot to be read correctly.

15.0. IMPRESSIONING OTHER TYPES OF LOCKS

15.1. Using the same basic principles as are used for pin tumbler and disk tumbler locks, many other types of locks can be impressioned also. Without going into detail about particular specialized techniques, some other types of locks that have been impressioned include:

Warded locks
Lever locks
Tubular locks
Chicago double bitted 11-wafer locks
Double-sided wafer locks
GM sidebar locks
Sargent Keso locks
Medeco locks

16.0. GLOSSARY



Blade
The part of the key that is inserted into the lock.
Blank
A key before any cuts have been made, or a key that is not fully cut and is thus not yet operational.
Bow
The handle of the key.
Cuts
"V" shaped notches cut out from the top of the blade for the purpose of raising the pins up to the shear line.
Depth
The depth of a cut is measured from the bottom of the blade up to the bottom of a cut. Depths are numbered starting with #0 (or sometimes #1) as the highest depth.

Grooves

Long narrow milled out areas along the sides of the blade to allow the blade to bypass the wards in the keyway.

Keyway

The part of the plug where you insert the key.

Lower pins

The pins of a lock that contact the cuts on the key. Also called bottom pins.

Pin stack

The combination of a lower pin sitting beneath an upper pin. In master keyed locks, additional master pins may be located between the lower and upper pins.

Plug

The part of the lock that you put the key into, and which turns to operate the lock.

Shear line

The dividing line between the plug and the shell (the height to which the tops of the lower pins must be raised to open the lock).

Shell

The outer part of the lock that surrounds the plug.

Shoulder

The edge of the key that touches the face of the lock to define how far the key is inserted into the lock.

Spool pin

A pin that has a groove cut around it's periphery. The groove is intended to catch at the shear line as a deterrent to picking.

Tang

The end of a file where a handle is to be attached.

Tip

The very end of part of the key that you stick into the lock first.

Upper pins

The pins in a lock that sit on top of the lower pins. Also called top pins.

Ward

Protrusions that stick out of the sides of the keyway to allow entry of only the correct type of key blank.

17.0. BIBLIOGRAPHY

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